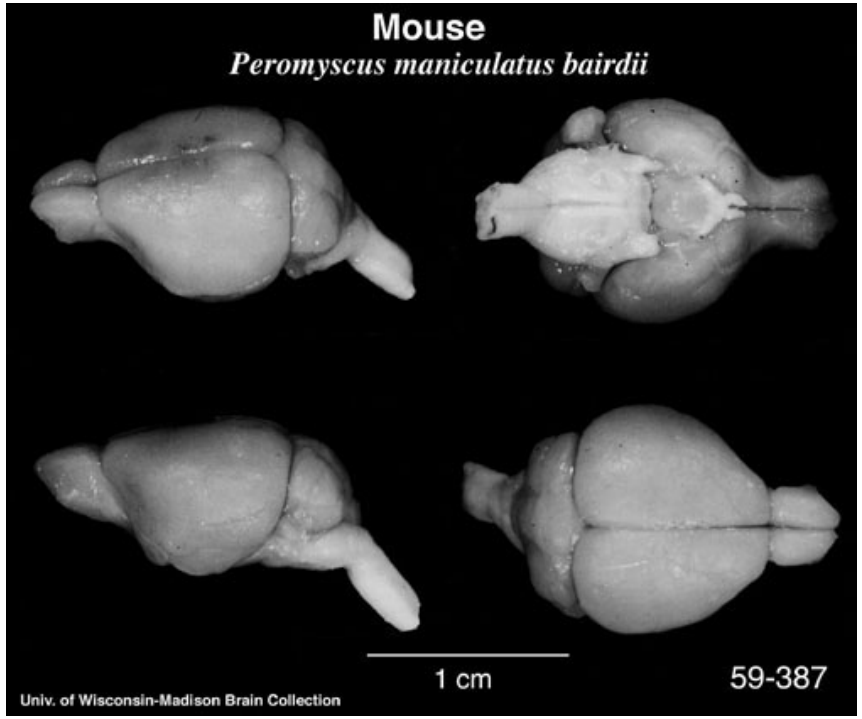
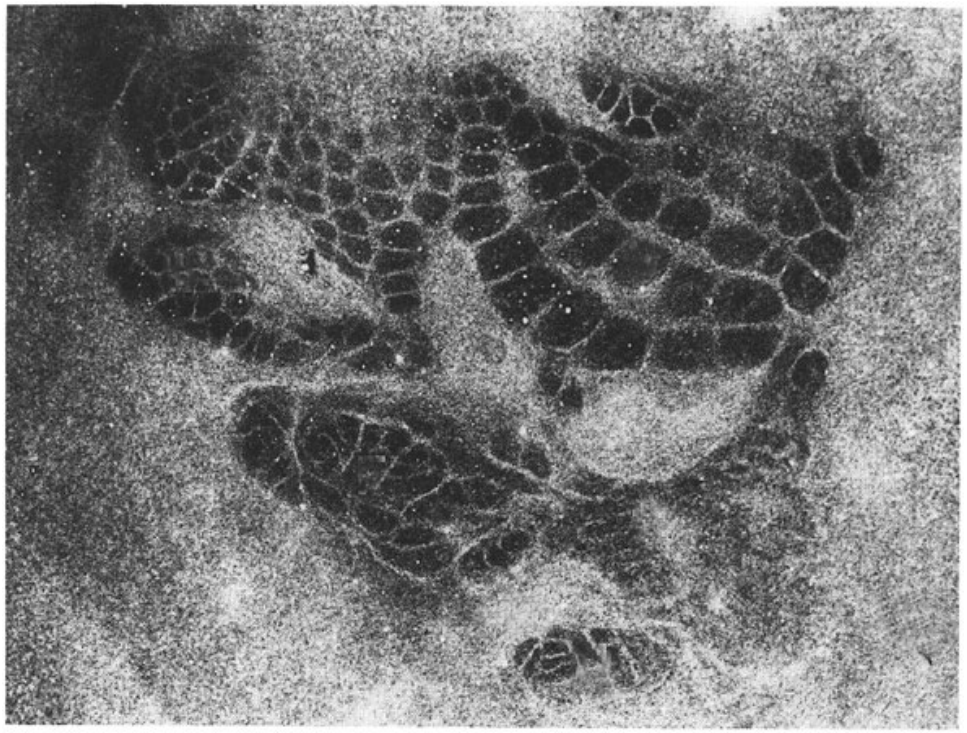
Whisker barrels – specialised anatomy and pathways

Development and critical period

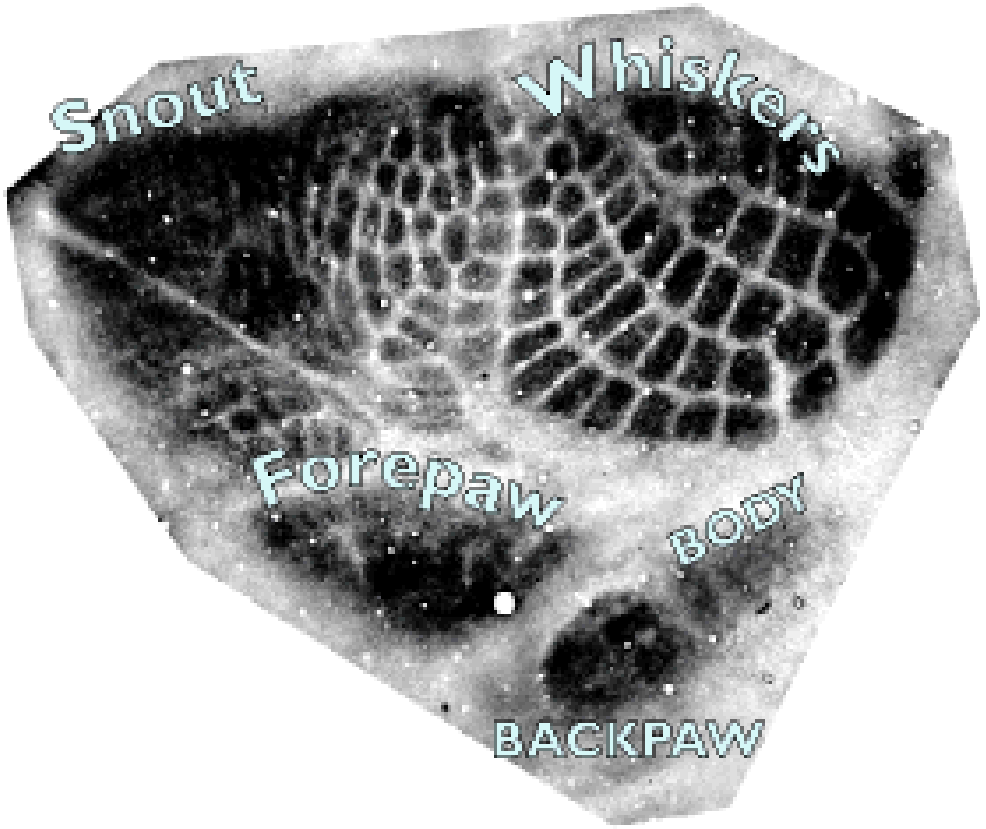
Rodentia: mice, rats, hamsters, and guinea pigs. Also includes beavers, muskrats, porcupines, woodchucks, chipmunks, squirrels, prairie dogs, marmots, chinchillas, voles, lemmings.

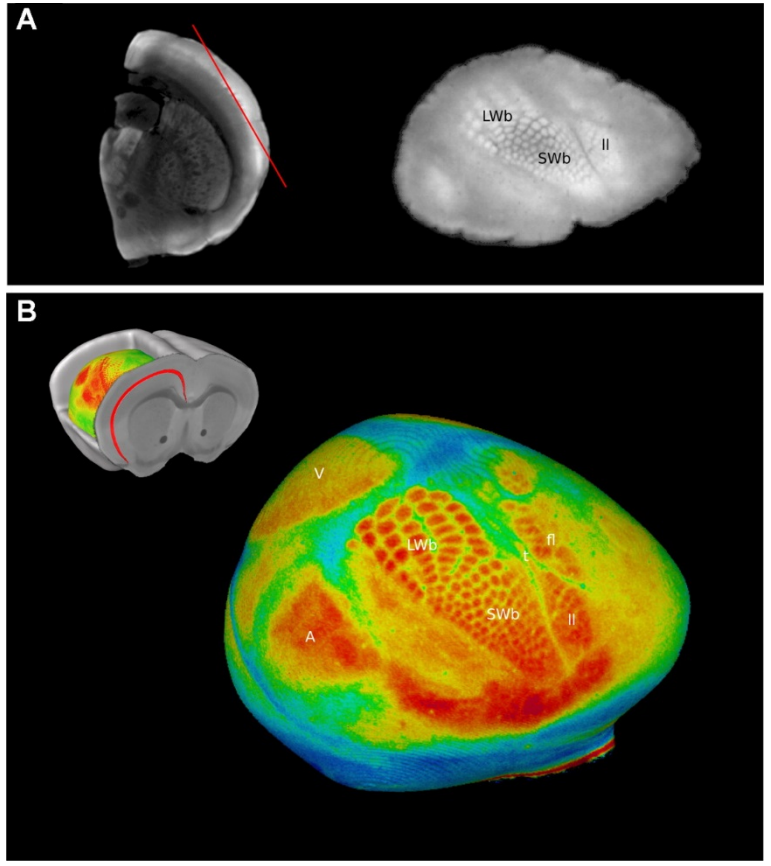
The mouse - unculus



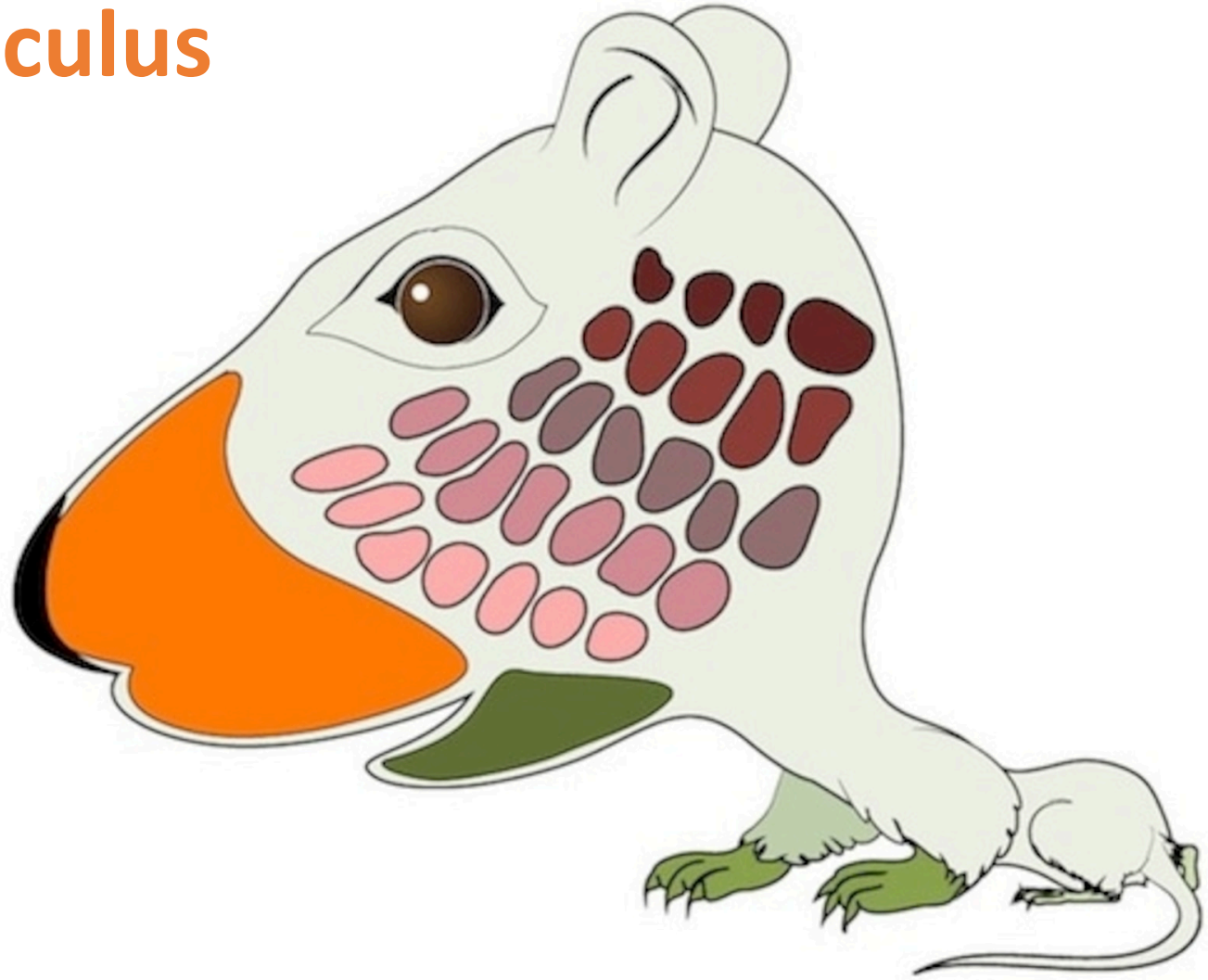


What's what in the mouse - unculus

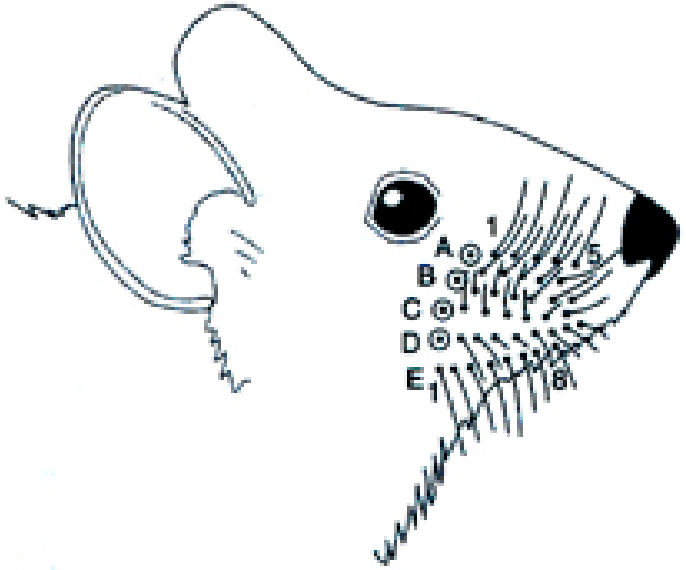




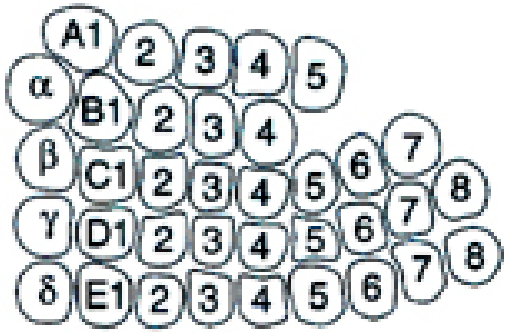
Mouse - unculus



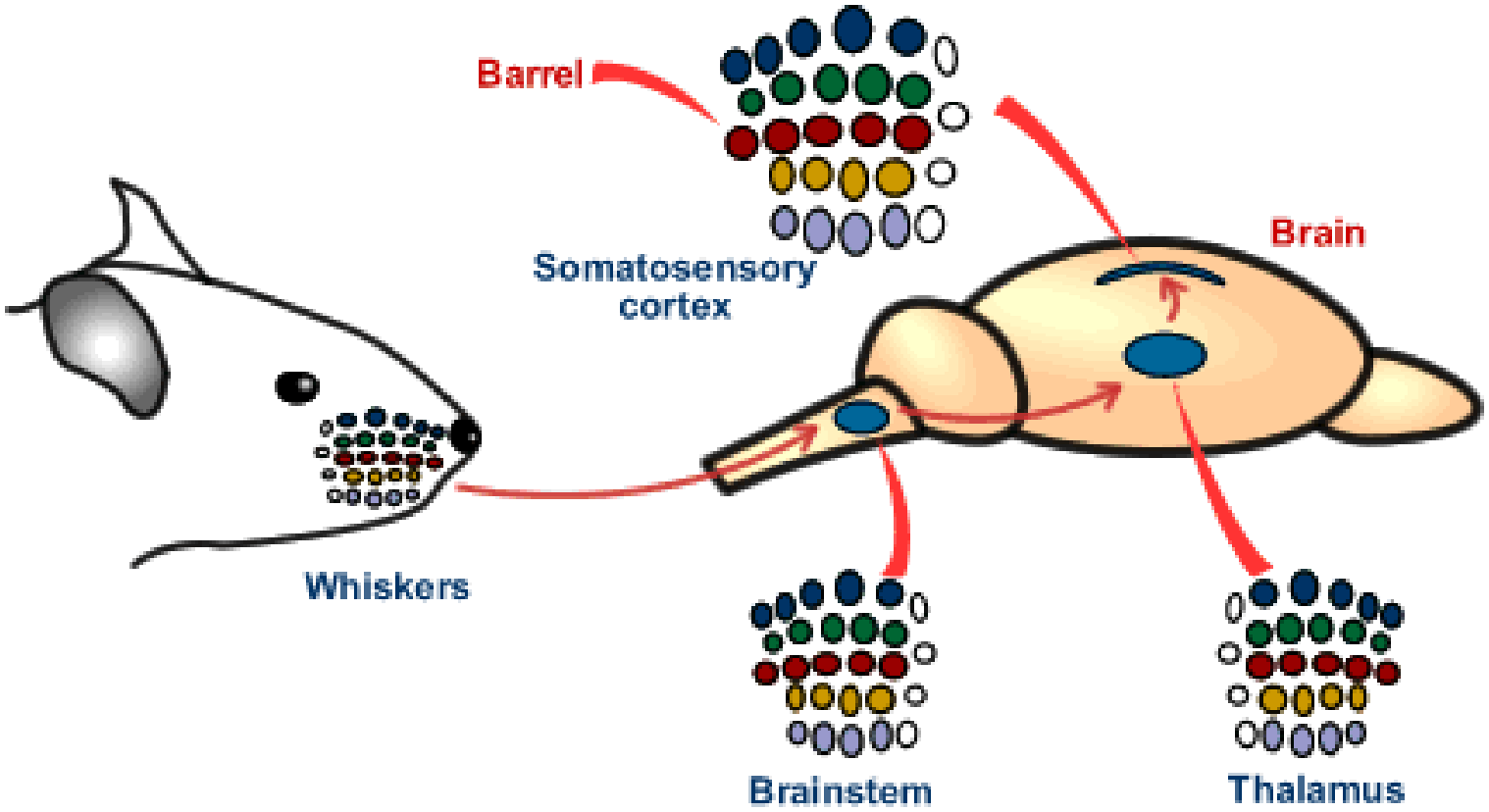
Vibrissae are in characteristic rows



Cortex



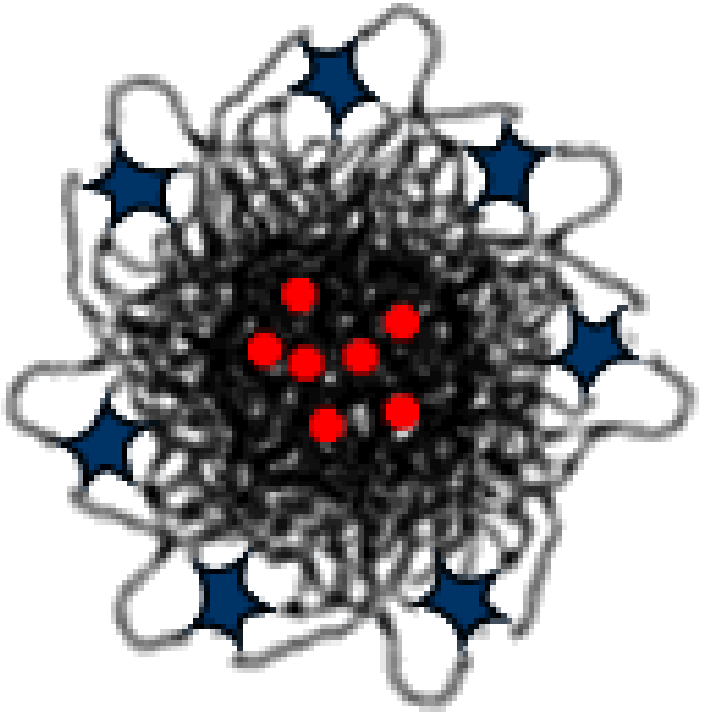
Whisker representation in rat



The somatosensory pathway transfers information from the whisker pad to the somtaosensory cortex such that each whisker is represented by a single neuronal structure - the barrel. Separate physical representations of the whisker pad can be throughout the pathway as indicated.

Cortical barrels

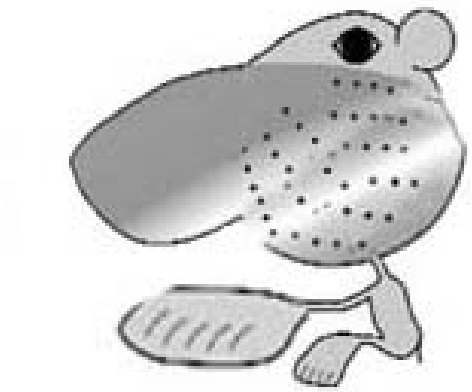
- **One per whisker follicle.**
- **Approx 2000 cells (neurons and glia) arranged in a ‘barrel’.**
- **Axons project into the centre of a barrel.**



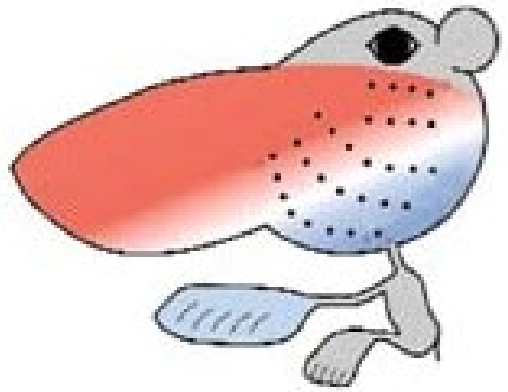
A barrel is formed by a ring of stellate cells with dendrites forming a dense network in the centre. The dendrites synapse with the axons rising from the thalamus

Genetic control of barrel development

Mouse-unculus



Genetically modified mouse: no Eph/ephrin gradients



Loss of scale representation

Environmental control
of barrel development -1

- **Remove whiskers at birth, lose corresponding barrels, neighbours get bigger.**

- **Remove whiskers after one week, no loss of barrels.**

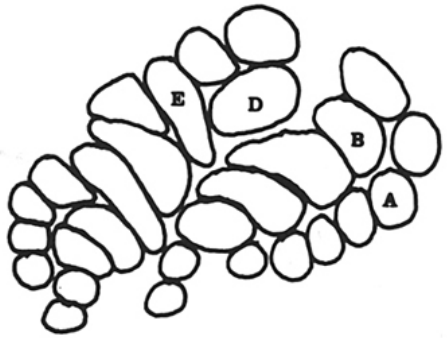
- **Graded response in between (critical period).**

Environmental control
of barrel development -2

Remove C row at 1,2,3,4,5,or 7 days after birth

(Adult pattern is shown)

1



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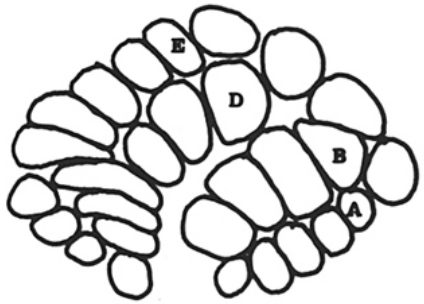

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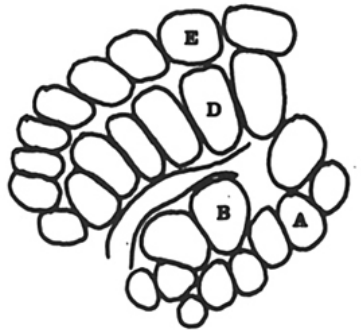

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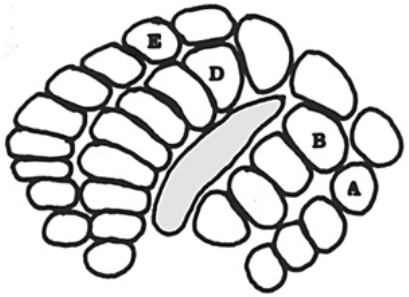

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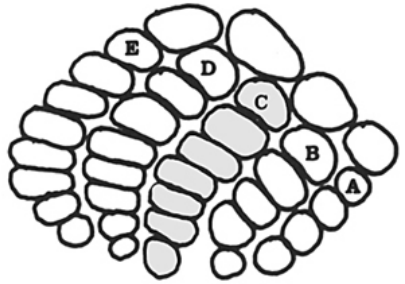
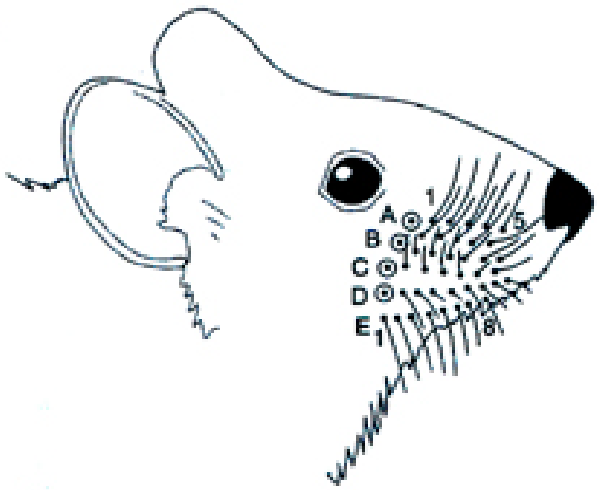
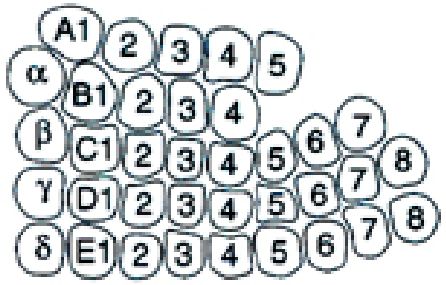


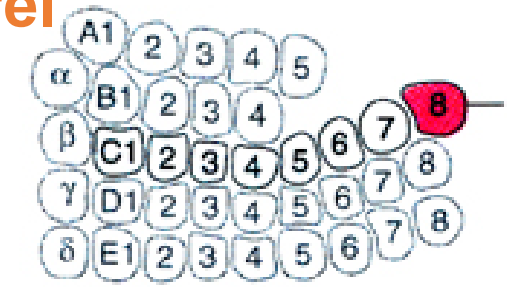
[As Normal]

Environmental control of barrel development -3





Extra whisker = extra barrel

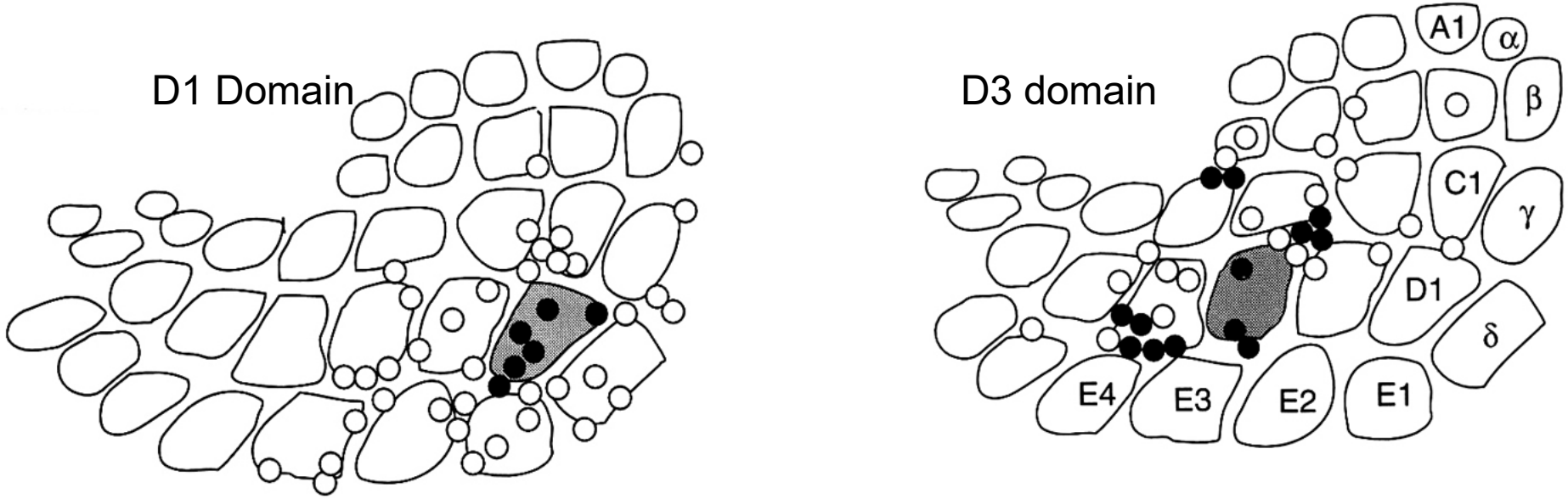


Environmental control of barrel development -4

Activity is needed to find the right barrel

Control adult

Antagonist to NMDA receptor to stop reinforcement of synchronised inputs



● Input from whisker corresponding to grey barrel

○ Input from other whisker

Key concepts: Whiskers and Barrel cortex development

Anatomical organisation of the whisker – barrel cortex projections

Experimental approaches to determining the critical period in barrel cortex development

Role of Eph-ephrin and NMDA receptors in barrel cortex development